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Original article

Applicability of eye trackers in marketing activities related to historical monuments. Comparison of experts' predictions and visual reactions of non-professionals

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ABSTRACT

The tests presented in the paper stemmed from the claims of a large portion of experts dealing with conservation of monuments, according to which applying eye trackers in the process of architectural heritage management is unnecessary. This gave an impulse for the author to check whether professionals are actually capable of accurate assessment of how different visual alterations affect the perception of a given monument by regular people. Should their predictions reflect the real reactions of an average viewer as registered by means of an eye tracker, such devices would prove redundant as far as the field of management of monuments is concerned. It was therefore decided to compare opinions of polled experts with the results of eye-tracking tests organized for a similarly-sized group of non-professionals. A simple issue was chosen for the test: the experts were supposed to choose the most and the least beneficial – in terms of color – variation of the logo that informs the visitors of the new function of Wrocław's Four Domes Pavilion. The results of the tests show that professionals do possess the knowledge necessary to assess the most basic issues, since they managed to point at the variants that proved most noticeable and most often neglected. However, they proved statistically incapable of predicting more complex responses of viewers – e.g. the relationship between the color of the logo and the amount of attention paid by viewers to the most important parts of the historical structure.

1. Introduction

It is a common occurrence in contemporary cities that an old mill becomes a hotel, a palace is transformed into a city office, and an old factory is repurposed for cultural events. Historical architecture might prove misleading for visitors as it does not give away the building's current function. Therefore it is a major challenge to adjust a contemporary intervention, even small-scale, such as a signboard, in such a way that it serves the informative role while at the same time does not disrupt the image of the monument in question [1,2]. There are clear and detailed guidelines that for example suggest using a limited number of colors in a logo as well as not employing very bright colors [1,2], but one may doubt whether these rules always prove beneficial both to the monument and to the informative role of a given sign. After all the structure that the logo is located on may be huge or tiny, compact or broken up into segments, toned down in terms of color or vivid and flashy. Moreover, the monument itself may constitute a sign or include one in its structure. It seems fairly impossible to come up with one set of rules for all such objects. Just like a poorly-designed logo may draw attention away from the characteristic features of a monument or even make it less likely to be noticed, it seems logical that a logo of appropriate size, location, and color [3] to only inform the public as to the monument's new function, but also emphasize some of its features or encourage people to look at it.

It might seem that the designers responsible for appropriate manifestations of the structure's new function base their choices mostly on individual esthetic preferences. Neither relatively unknown nor internationally acclaimed architects exhibit much need to confront their actions with the actual effect they might have on the viewers. In the majority of cases the people who assess their solutions are other professionals – conservation officers or directors and boards of various institutions that commission the given design [4]. Even when it comes to competitions, the winning design is chosen by a narrow group of decision-makers on the basis of their expectations as to how the design will affect the observers [5]. The strategies related to maintaining the quality of historical surroundings, even those that the professionals see as the most attractive, are not sustainable since they do not engage the local community in the decision-making process [6,7]. It is the author's suggestion to employ eye-tracking tests in such processes in order to diagnose the visual reactions of average observers seeing the planned modifica-

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Fig. 1. The original photo used as the basis for the tests (fot. M. Lulko).

tions, both small-scale ones, such as placement of an advertisement and large-scale ones, such as an expansion of the building itself [8–10]. In practice this suggestion has often met with criticism based on the belief that the professionalism of the experts 'speaks for itself' [11]. Some people who are professionally engaged in protection of cultural heritage claim that eye-tracking tests of how historical monuments are perceived give predict results and are, therefore, redundant. Some of the people who have expressed this view while talking to the paper's author and are worth mentioning due to their current function are professor Jakub Lewicki, the Mazovia Voivodeship Conservator of Monuments, or Barbara Obelinda, the Lower Silesian Voivodeship Conservator of Monuments.

1.1. Eye trackers and architecture

Although eye-tracking studies are conducted all around the world, application of these devices in research related to architectural and urban heritage remains a novelty. Even so, eye trackers have been used for a few purposes, for example while researching the relationship of architecture and landscape [12], the perception of traditional historical architecture [13] or architecture in an urban context [14]. Researchers have also been interested in exhibition interiors and using eye trackers in museums [15,16] or in optimizing the design and placement of safety signs in public buildings [17].

2. Research aim

The purpose of the research presented herein is to verify the usability of eye-tracking tests in the context of participatory management of cultural heritage. The tests involved an image of a historical monument shown with different versions of the same information sign. A comparison was carried out of experts' expectations related to these images and the reactions of non-professionals. The research was therefore divided into two parts. In the first one, the experts expressed their views in a traditional survey. In the second part, lay people's visual responses were registered by means of a stationary eye tracker.

2.1. The hypothesis

What this paper wants to explore is whether experts' expectations about how information signs influence a regular person's perception of the monument they are placed on will match actual reactions registered by means of an eye tracker. Should the experts prove able to accurately assess this influence without using an eye tracker, it would mean that the introduction of such devices in order to improve the quality of cultural heritage management is unnecessary.

It is also possible that this study will show whether it is always the right solution to treat a logo as an object whose characteristics must be derived from its historical background.

2.2. Choice of topic and justification for narrowing the range of research

It was decided to use a small-scale intervention – in this case a sign that informs the public about the historical monument's modern function. The tests could be applied to a wide range of locations and numerous aspects of corresponding signs, their size, shape, color, and placement. However, due to the methodology of the study it is impossible to compare the influence of so many variables. Therefore one specific aspect had to be chosen. The author decided on the award-winning logo ('Muzeum Widzialne' contest) of the National Museum in Wrocław.[1] The logo, which is a large letter M, is used next to the entrance of the UNESCO-listed monument Four Domes Pavilion and the photo of the building's façade was the basis for all the images used in the tests.

There are two reasons for the choice of this particular subject. Firstly, in all the advertising materials the logo which had been prepared for the Four Domes Pavilion was blue, but in reality it is white. It makes one wonder who decided to change this color and why. Was making the sign white instead of blue a good decision? Does this color of the letter make it easier to pay attention to the architecture of the building? The multitude of arising questions and the fact that it is a current topic made it possible to obtain a substantial response from a considerable group of professionals.

The secondo reason was the relation between the name and the architectural structure of the monument. Its most important feature are the four wings, each with a dome placed in its middle [18]. In order to allow the public to understand the idea behind the building's composition, it seems that interventions should be

[1] https://muzeumwidzialne.pl/laureaci,101,laureaci_muzeum_widzialne_2017.html.

planned so that they do not diminish the visual importance of the domes.

3. Materials and methods

3.1. Visual stimuli for both stages of research. The choice of the basic photograph

In tests centered around a photo, the time when it is taken always narrows down the subject of the research. In urban surroundings there are numerous variables that affect the perception of an image: the time of day, the weather conditions, presence of people and animals, as well as the plants around the building. For the purpose of this test a photo was chosen that was characterized by a clear blue sky, strong lighting that emphasizes the tectonics of the building, and a lack of other elements that might distract the viewers. An opposite example would be a photo taken during a rainy evening, including trees with many-colored leaves as well as cyclists and passers-by – and in such a case all these elements could draw the people's attention away from the monument and its logo.

3.2. Color alterations of the logo

The first step in the preparation for the research was to create the visual stimuli to be presented during both stages of the tests. By means of simple modifications the aforementioned white letter M (Fig. 1), while maintaining its shape, was turned to black (RGB 5,6,7), emerald green (RGB 11,144,113), cardinal red (RGB 229,30,30), cyan blue (RGB 22,171,227). It was also decided to prepare a variant with a cream-colored logo (RGB 198,199,185), in order to check the effect of having both the logo and the building in the same color on people's perception of the building's composition and on the readability of the information sign. The images including the green and the blue logo proved to look very similar (Fig. 2) – to the point where people previewing the images before surveying the experts were in doubt whether the same image had not been used twice by accident.

In preliminary eye-tracking tests very similar results were received for these two images. The green logo was spotted on average after 0.8 s, and observed for 15–20% of time, the blue logo was noticed after 0.6 s, and observed for 14–22% of time. The preliminary tests were carried out on 18 students of architecture at the Wrocław University of Science and Technology and their results were not included in the calculations done for the actual tests. As a result the image with the green logo was not used in the actual tests.

3.3. First stage – experts' opinions

In order to learn the opinions of experts about the different graphic variations, a short survey was prepared. It included a brief introduction explaining the purpose of the study as well as the reason why their help is needed.

> "...I study the perception of contemporary changes made in historical structures. I conduct eye-tracking tests showing how non-professionals would look at the façades of the Four Domes Pavilion depending on the color of the logo placed near its entrance. I am asking for your help in obtaining an expert's view that will serve as a reference point for this experiment..."

The first three questions were about the sex, profession and professional experience of the participants. The following questions were formulated in such a way as to make it possible to compare them with the data obtained during the planned eye-tracking tests as well as to find out the motivation behind the experts' decisions.

The first two questions were connected with the main visual features of the information sign:

(1) Which logo, visible on the presented façade, would in your opinion be most quickly and most often spotted by the viewers?
(2) Which logo would accidental passers-by look at the longest?

The next three questions were related to a significant issue of creating conditions that would prove beneficial for the comprehension of the nature of the historical monument presented in the images.

(3) Which color variations show the logo least likely to distract the viewers from looking at the dome of the monument (the viewers look the longest at the dome and the drum that supports it)?
(4) Which of the presented logos would be the least likely to encourage the viewers to look carefully at the monument?
(5) Thanks to which logo would the viewers look at the monument's façade the longest?

The next two questions were supposed to serve as a summary, in which the respondents were to point out the best and the worst variation in their opinion.

(6) If the choice was up to you, which of the presented variations of the logo should be applied?
(7) Is the use of any of those logos unacceptable in your opinion?

Nearly all questions allowed marking more than one answer as correct. Only question number six required giving one specific answer. An additional question that ended the obligatory part of the questionnaire was related to the justification of the decisions made in the last two questions. Willing participants were also able to explain their answers to previous questions as well as to give comments.

3.3.1. Participants' characteristics

In many countries – Poland not excluded – the people who may influence the form of a logo placed in a historical context belong to a wide group of professionals with extremely varied education. That is why the link to the questionnaire[2] was distributed in social media and sent via e-mail to workers of universities (offering courses in architecture (including protection of monuments), art, museums, design and marketing), conservation offices, research institutes, and museums located in big Polish cities. 269 people took part in this stage of research. Finally, the answers from 241 participants, who could without a doubt be classified as professionals in the field, were taken into account.

3.3.1.1. Detailed characteristic of participants:. 60.9% answers were given by women and 38.7% by men. The participants had highly diversified education. The questionnaire made it possible to select several specialties. 86 participants were architects or urban planners, 57 declared themselves as historians of art or architecture. 40 surveys were completed by graphic artists, visual artists and designers. 24 answers were given by museum scholars or museum management workers. 25 participants were conservation officers, out of which 19 claimed to actually work at a conservation office. 10 people identified themselves as marketing specialists, and two people were landscape architects. Two psychologists also took part in the survey. Out of all participants, 68, which is nearly 30%, identified themselves as university teachers. The answers taken into account came from 31 engineers, 124 MAs or MSCs, 71 PhDs, 8 professors. One person, even though lacking formal education, was considered an expert since they had over 20 years of professional and teaching experience. 41 people included in the calculations had had from 1 to 5 years working experience, 53 people had worked

[2] Data available at https://docs.google.com/forms/d/1DadUHydjRdt65NEuuXs65fg1ava3gxK3aftxgiCTlpA/edit#responses.

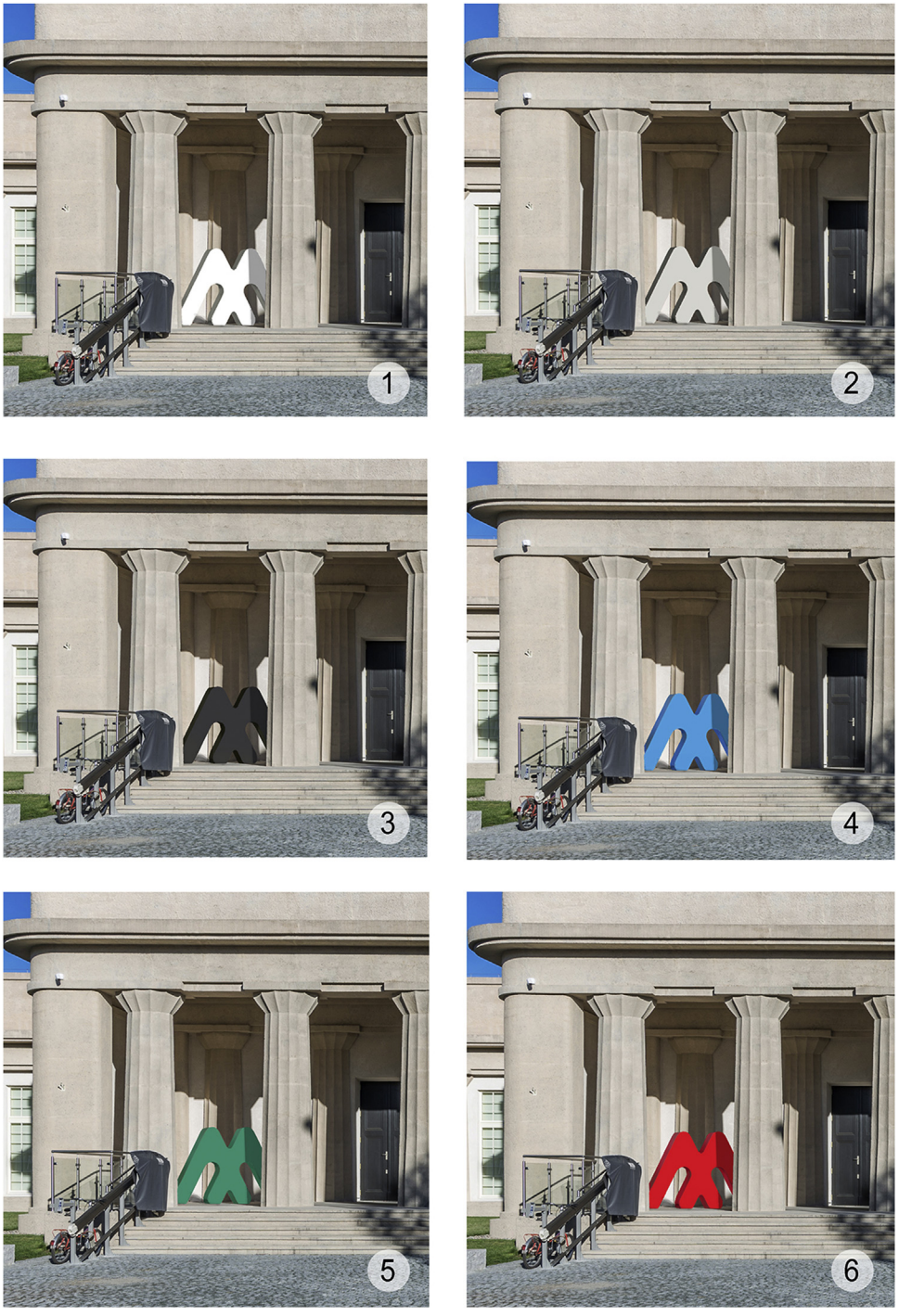

Fig. 2. The modified fragments of the visual stimuli as follows: 1 – black logo, 2 – the original photo with white logo 3 – green logo (finally not used in the tests), 4 – blue logo, 5 – cream-colored logo, 6 – red logo (Marta Rusnak).

for 6–10 years, 89 people had had a working experience of 11–20 years and 47 people had done their job for more than 20 years.

3.4. Analysis of the experts' opinions

From the perspective of public opinion research 241 participants is a small sample, but at the same time it is much bigger than the usual size of a competition committee, which is a typical form of choosing solutions in the fields of architecture, conservation, and museum management.

The variety of participants proved problematic during the analysis, not only due to differences in age, education or experience, but also because a lot of these people could be deemed professionals in more than one field. That is why the gathered data was analyzed in three ways:

(A) collectively – for all participants
(B) with division into people with bigger or smaller work experience

The less experienced group included those with a Bachelor's or Master's degree and less than 20 years of work experience. This group consisted of 134 people. The other group included professionals with over 20 years of experience in the field as well as Ph.D.s and university professors. This group consisted of 107 people.

(C) with division into subgroups representing four most numerous professions: architects, conservators, museologists and graphic designers.

Many participants could boast from two to even four fields of expertise. That is why each of these subgroups includes additional information about the number of participants who specialize only in this one particular field of knowledge.

3.4.1. Visual characteristics of the logo itself – answers to questions 1 and 2

3.4.1.1. Question 1 – the logo noticed the most quickly. The answers given to questions 1 and 2 were relatively unanimous. All experts have chosen the red logo as the most noticeable, as almost 92% of them chose this option. The next color considered most eye-catching was blue. In contrary to what happened with questions to follow, the respondents quite often selected two or three equally good solutions here. Only two participants stated that it would be difficult for them to point out the logo whose color would make it the easiest to spot. The analysis of subgroups, both for criteria B and C, did not show noticeable discrepancy from the preferences observed for the entirety of the participants (Attachment 1).

Question 1		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	Difficult to say
Analysis type	Group name							
A	All professionals	241	9.1%	2.1%	2.5%	26.1%	**91.7%**	0.8%
B	More experienced	107	9.4%	2.8%	0%	25.4%	**95.3%**	0%
	Less experienced	134	8.9%	1.4%	4.5%	26.8%	**88.8%**	1.4%
C	All architects	86	7.0%	0%	1.0%	22.1%	**95.3%**	2.3%
	Only architects	36	0%	0%	0%	25.0%	**72.2%**	2.7%
	All art historians	44	6.8%	2.2%	2.2%	27.3%	**75.0%**	0%
	Only art historians	27	3.7%	3.7%	3.7%	37.0%	**85.2%**	0%
	All graphic designers	40	12.5%	0%	5.0%	25.0%	**85.0%**	2.5%
	Only graphic designers	21	14.3%	0%	0%	19.1%	**85.7%**	4.8%
	All conservators	30	16.7%	0%	3.3%	23.3%	**80.0%**	0%
	Only conservators	12	8.3%	0%	0%	25.0%	**83.3%**	0%
	All museologists	24	8.3%	0%	0%	25.0%	**79.2%**	0%
	Only museologists	15	6.7%	0%	0%	26.7%	**86.7%**	0%

Attachment 1 / Answers to question 1.
The types of logo which drew the viewers' attention most quickly and most often.

3.4.1.2. Question 2 – the logo drawing attention for the longest. More than a half of the survey's participants (56.8%) decided that the red logo would be the one drawing attention for the longest. Over a quarter expected the blue logo to be looked at the longest. It might be slightly surprising that as much as 10% of experts were not willing to make this choice, especially since there was no such hesitation in the previous question.

Work experience of participants did not influence the answers given in any considerable way (Attachment 2). In virtually all groups the two most often chosen options were the red one and the blue one respectively. Most certain of their opinion were the groups including people professionally dealing with museum science as well as the group of participants whose only education was in conservation. There was no one in these three sets who refused to point at a particular solution. 60% of those who declared themselves as only museologists was certain that red will draw attention the best. Graphic designers proved the most indecisive as 15% of them decided not to give a specific answer, as a result of which not only were the red and the blue logos chosen less often than by other groups, but also there was almost no difference between how often these two answers were given.

Question 2		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	Difficult to say
Analysis type	Group name							
A	All professionals	241	8.7%	7.9%	3.7%	28.2%	**56.8%**	10.0%
B	More experienced	107	6.6%	6.6%	3.8%	27.4%	**57.5%**	10.4%
	Less experienced	134	10.4%	8.9%	3.7%	29.1%	**55.9%**	9.7%
C	All architects	86	7.0%	8.1%	2.3%	27.9%	**41.9%**	10.4%
	Only architects	36	11.1%	5.6%	0%	22.3%	**44.4%**	5.6%
	All art historians	44	6.8%	9.1%	4.5%	25%	**45.5%**	9.1%
	Only art historians	27	7.4%.	0%	0%	22.2%	**55.6%**	11.1%
	All graphic artists	40	7.5%	10.0%	2.5%	35.0%	**32.5%**	15.0%
	Only graphic artists	21	9.5%	4.8%	4.7%	23.8%	**23.8%**	23.8%
	All conservators	30	10.0%	6.7%	10.0%	23.3%	**46.7%**	3.3%
	Only conservators	12	8.3%	8.3%	8.3%	25.0%	**58.3%**	0%
	All museologists	24	4.2%	8.7%	0%	29.2%	**54.2%**	0%
	Only museologists	15	6.7%	6.7%	0%	26.7%	**60.0%**	0%

Attachment 2 / Answers to question 2.
The types of logo that the viewers would look at the longest.

3.4.2. Visual relationship between the logo and the monument – answers to questions 3, 4 and 5

3.4.2.1. Question 3 – The logo that lengthens the time spent looking at the dome. The majority of experts decided that the cream-colored logo would make the viewers spend the most time looking at the dome and the drum that supports it. Quite a few also pointed at the black logo. Very few chose the blue or the red or blue variation (Attachment 3). No significant discrepancies were noticed when the answers to this question were analyzed for different professional subgroups and for people with varied work experience. The participants were very sure of the answers to this questions and less than 13% selected more than one.

Question 3		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	Difficult to say
Analysis type	Group name							
A	All professionals	241	10.0%	**70.6%**	27.8%	0.8%	5.0%	2.5%
B	More experienced	107	8.5%	**70.5%**	30.2%	0%	5.7%	0.7%
	Less experienced	134	11.2%	**70.9%**	25.4%	1.4%	4.5%	3.7%
C	All architects	86	11.6%	**61.6%**	17.4%	0%	3.5%	5.8%
	Only architects	36	8.3%	**69.4%**	11.1%	0%	2.8%	5.6%
	All art historians	44	4.5%	**65.9%**	13.6%	2.2%	6.8%	4.5%
	Only art historians	27	7.4%	**63.0%**	11.1%	3.7%	7.4%	7.4%
	All graphic artists	40	12.2%	**57.5%**	25.0%	0%	0%	5.0%
	Only graphic artists	21	14.3%	**61.9%**	23.8%	0%	0%	4.8%
	All conservators	30	0%	**63.3%**	20.0%	3.3%	10.0%	3.3%
	Only conservators	12	0%	**66.7%**	16.7%	8.3%	8.3%	0%
	All museologists	24	4.2%	**70.8%**	16.7%	4.2%	0%	0%
	Only museologists	15	6.6%	**73.3%**	20.0%	6.6%	0%	0%

Attachment 3 / Answers to question 3.
The types of logo that would make the viewers look the longest at the dome and the drum supporting it.

3.4.2.2. Question 4 – The logo that reduces the interest in the monument. The first serious difficulties with assessing the relationship between the logo and the perception of the monument appeared when the experts were asked about the color of the logo which would reduce the interest in the monument to the greatest extent. Most experts (24.5%) decided that red logo would be the least suitable, however, the black and cream-colored logos were also chosen by more than a fifth of participants each. While looking at the entirety of the analysis (Attachment 4) one may claim that the preferences of nearly all groups are the same. The only exceptions were people whose only field is conservation – they pointed at the red logo with more certainty – and graphic designers, who were the only ones to choose the cream-colored logo as the one which will be the least likely to help focus the public's attention on the building's façade.

Question 4		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	Difficult to say
Analysis type	Group name							
A	All professionals	241	6.2%	**20.7%**	**21.2%**	12.4%	**24.5%**	12.4%
B	More experienced	107	7.6%	**19.8%**	**25.5%**	14.9%	**25.5%**	8.5%
	Less experienced	134	4.5%	**21.5%**	**17.8%**	16.3%	**28.3%**	15.7%
C	All architects	86	1.2%	**27.9%**	**20.9%**	17.4%	**19.8%**	14.0%
	Only architects	36	0%	**27.8%**	**27.8%**	13.9%	**19.4%**	11.1%
	All art historians	44	4.5%	**15.9%**	**18.2%**	15.9%	**29.5%**	15.9%
	Only art historians	27	3.7%	**22.2%**	**22.2%**	9.1%	**18.5%**	18.5%
	All graphic artists	40	5.0%	**37.5%**	**12.5%**	10.0%	**30.0%**	5.0%
	Only graphic artists	21	4.8%	**23.8%**	**23.8%**	9.5%	**33.3%**	4.8%
	All conservators	30	0%	**16.7%**	**16.7%**	10.0%	**40.0%**	13.3%
	Only conservators	12	0%	**8.3%**	**25.0%**	8.3%	**33.3%**	25.0%
	All museologists	24	4.1%	**20.8%**	**20.8%**	12.5%	**29.1%**	12.5%
	Only museologists	15	0%	**20.0%**	**20.0%**	20.0%	**26.7%**	6.7%

Attachment 4 / Answers to question 4.
The types of logo that would make the viewers the least interested in looking at the monument.
The results of the survey show that in this case it was much more difficult to choose an answer – 30 out of 241 people (12.4%) decided that they were not able to assess this aspect of the relationship. The least experienced participants were the most reluctant to give an answer. It was possible to observe a considerable uncertainty in almost all subgroups.

3.4.2.3. Question 5 – The logo most contributing to looking at the monument. The fifth question was concerned with the color of the logo that contributed the most to the time viewers would spend on observing the façade of the monument. A definite majority of the participants decided to select one specific answer rather than two or three equally good ones. 24 participants (10%) gave no answer at all (Attachment 5). Most experts decided that the logo variations that would increase the amount of time spent by viewers on looking at the monument's façade are the ones in the least vivid colors – cream (30.3%) or white (27.4%).

Question 5		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	Difficult to say
Analysis type	Group name							
A	All professionals	241	**27.4%**	**30.3%**	16.2%	9.5%	9.1%	10.0%
B	More experienced	107	**26.4%**	**30.2%**	17.9%	10.4%	9.4%	8.5%
	Less experienced	134	**28.3%**	**33.6%**	14.9%	8.9%	8.9%	11. 2%
C	All architects	86	**25.6%**	**22.1%**	9.3%	9.3%	9.3%	14.0%
	Only architects	36	**36.1%**	**22.2%**	8.3%	11.1%	8.3%	13.9%
	All art historians	44	**18.2%**	**34.1%**	18.2%	4.5%	15.9%	9.0%
	Only art historians	27	**11.1%**	**33.3%**	22.2%	7.4%	18.5%	7.4%
	All graphic artists	40	**27.5%**	**30.0%**	17.5%	10.0%	5%	10.0%
	Only graphic artists	21	**33.3%**	**28.6%**	9.5%	0%	4.7%	9.5%
	All conservators	30	**30.0%**	**30.0%**	13.3%	0%	3.3%	23.3%
	Only conservators	12	**25.0%**	**33.3%**	8.3%	0%	0%	0%
	All museologists	24	**16.7%**	**45.8%**	16.7%	0%	8.3%	8.3%
	Only museologists	15	**13.3%**	**60.0%**	20.0%	0%	13.3%	13.3%

Attachment 5 / Answers to question 5.
The types of logo that would make the viewers most willing to spend time looking at the façade of the monument.

There was no unanimity in the answers to this question. Once again approximately 10% of participants chose not to make a clear decision. In the part of the survey allowing comments 3.9% participants wrote that in their opinion none of the variations is appropriate and came up with other ideas. It is possible that a bigger diversification in the answers stems from the fact that participants were required to select just one response. Virtually all colors garnered some approval from the experts: black,[3] red,[4] cream[5] and white[6] were all chosen relatively often, with cream being the most often decided on. The fewest people chose the blue logo. Those in favor of the blue logo described it as noticeable but not aggressive. Only one participant mentioned the fact that such variation would be best since it would be coherent with the color of the promotional materials about the Four Domes Pavilion that had been created by the National Museum in Wrocław.

stated that the cream-colored logo is too 'dirty', 'drab', and easy to overlook. One participant claimed that this variation of the logo looked as if something had dropped off the façade of the museum and because of this ambiguity many people could possibly look at it for a long period of time without realizing what it is. The variation that accumulated the fewest reservations was the white one. Those who decided to justify the choice of the white logo deemed it too banal, lacking character.

The full picture of the analysis can be seen in Attachment 6 (Attachment 6), which shows little discrepancy as to the unaccepted solutions – these proved to be mostly red and blue letters. In the part C of the analysis one should point at the graphic designers who accepted the fewest solutions (27.5% for all graphic designers and 33.3% for "only graphic designers") and who were most reluctant to accept a cream-colored logo (23.3% and 26.3% respectively).

Question 6		Group size	White logo	Cream-colored logo	Black logo	Blue logo	Red logo	All acceptable
Analysis type	Group name							
A	All professionals	241	2.9%	12.4%	12.0%	27.8%	40.3%	41.1%
B	More experienced	107	1.2%	11.1%	8.6%	27.2%	40.7%	40.7%
	Less experienced	134	3.6%	13.7%	15.2%	28.4%	40.1%	41.6%
C	All architects	86	3.4%	9.3%	10.5%	30.2%	40.0%	38.4%
	Only architects	36	5.6%	13.9%	13.9%	30.6%	38.9%	36.1%
	All art historians	44	9.1%	0%	16.0%	18.2%	31.2%	56.8%
	Only art historians	27	7.4%	0%	14.8%	22.2%	29.6%	55.6%
	All graphic artists	40	2.5%	26.8%	20.0%	27.5%	34.1%	27.5%
	Only graphic artists	21	0%	23.8%	23.8%	28.6%	28.6%	33.3%
	All conservators	30	6.6%	10.0%	13.3%	13.3%	36.7%	40.0%
	Only conservators	12	8.3%	8.3%	8.3%	25.0%	33.3%	33.3%
	All museologists	24	8.3%	0%	12.5%	33.3%	33.3%	37.5%
	Only museologists	15	0%	0%	6.7%	33.3%	40.0%	40.0%

Attachment 6 / Answers to question 6.
Which logo should most definitely not be applied.

In general, the tendency presented above applies to the other two parts of the analysis. The only discrepancy is that the museologists would chose the cream-colored logo if they wanted to increase the time spent by the public looking at the monument (45.8% for all museologists and 60% "only museologists" – those who declared just one field of expertise) (Attachment 5).

3.4.3. Question 6 – The worst solution

Since one was able to select more than one answer to this question, numerous experts decided to do just that (nearly 35%). Paradoxically, as much as 41.1% of participants claimed that all variations are acceptable. This decision was justified, among others, by the relatively small size of the logo in comparison to the building. Approximately 40% of participants stated that using the red logo would be unacceptable. This variation was described as aggressive, irritating, flashy, standing out, disharmonizing, unelegant, deterrent or even intolerable. Over 27% of professionals were against applying the blue logo. This reluctance was explained by saying that the blue logo appears as strange, too modern, cheesy, and that it is not compatible with the calm façade. 12% decided that the black logo would be the worst choice. The black logo was described as somber or funerary, and considered not to serve its basic purpose which is to inform and draw people's attention. One person mentioned the fact that such logo was unfavorably coherent with the door and the shadows of trees which made it fade into the background.

A slightly larger number of volunteers (12.4%) said the same thing about the cream-colored logo. The explanations of this group

3.4.4. Conclusions of the analysis

Even though the people who took part in the study varied greatly in terms of education and experience, the data shows numerous shared preferences and visible tendencies as far as their answers are concerned. In some cases the numerical data for subgroups of different character is astonishingly similar.

3.5. Hypotheses formulated on the basis of surveyed experts'

Thanks to the survey carried out among the experts, the author managed to formulate the following hypotheses that would be verified in the second part of the research.

- Hypothesis 1. The red and the blue logo will be the ones noticed by most viewers and spotted the most quickly. Those two vivid options will also be the ones that viewers spend most time looking at.
- Hypothesis 2. The black and the cream-colored logo will be the easiest to overlook.
- Hypothesis 3. The red logo will be the one to contribute the least to the viewers' interest in the building's architecture.
- Hypothesis 4. The cream-colored logo and the white logo will allow the viewers to observe the Four Domes Pavilion to the greatest extent.
- Hypothesis 5. The cream-colored logo will make the viewers pay the most attention to the dome and the drum that supports it.

3.5.1. Observation

Should one compare the data from Attachments 1 and 2 with the results displayed in Attachment 6, it is possible to claim that most professionals participating in the survey deemed the informative function of the logo much less important than the sign's esthetic coherence with the monument. It is particularly noticeable in rela-

[3] Those in favor of the black logo pointed at the elegance of such solution.
[4] The choice of the red logo was justified by its excellent visibility and by the fact that it matches the bold nature of the collection exhibited inside.
[5] It was described as remaining in harmony with the monument, matching the atmosphere of the surrounding area or being the least harmful to the monument.
[6] It was described as clean and modern, "noticeable yet not flashy".

Fig. 3. Reference image with the removed logo (Marta Rusnak).

tion to the red and the blue logos – while definitely chosen as the most visible, they were also described as the least acceptable solutions. On the other hand, the cream-colored logo and the black one, while considered less informative and easier to be overlooked, were much more willingly chosen by the experts as the best variation. In the light of this observation it may appear that hypotheses 3, 4, and 5 are of slightly bigger significance than hypotheses 1 and 2.

3.6. Second stage of research – eye-tracking tests

3.6.1. Description of the equipment used and the process of data collection

Contemporary technology makes it possible to coordinate five elements – the infrared light emitters, cameras tracing the movement of the pupils, a screen with specific parameters, a central unit and specialized software that lays the observed movements of one's eyes over the presented image – in order to obtain a precise mathematical analysis of a person's eye movements and, as a consequence, of what they look at and how they do it. In this test we used a Tobi Pro X3-120 stationary eye tracker set at the frequency of 120 Hz, mounted above a 21" screen which displayed the tested images. The device was calibrated for each participant individually by means of a five-point calibration (https://www.tobiipro.com/learn-and-support/learn/eye-tracking-essentials/what-happens-during-the-eye-tracker-calibration/). The computer registered the movements of each person's eyes with the division into fixations – periods of maintaining one's gaze on a particular spot [19,20] – and saccades, that is the moments when visual attention is transferred between such spots [19,20]. The data was collected and then processed by means of the TobiProLab software.

3.6.2. Methodology of the eye-tracking test

Eye-tracking tests were carried out for a series of the same illustrations that had been shown to the experts (Figs. 1 and 2). At this stage it was necessary to include a reference image, that is a photo with the logo removed entirely (Fig. 3), which made it possible to study the influence different logos have on the perception of the building's façade. The parts of the screen that did not display the images were of a neutral gray color (RGB 130,130,130).

All the objects that could potentially distract the participants had been removed from the room in which the tests took place. The laboratory had white walls and a gray floor. The furniture inside comprised of two desks, three chairs, a bookcase on which the documentation for the tests was collected and the electronic equipment employed during the tests.

People who were invited to participate in the tests were all adults under 65 entirely lacking in education or experience related to the subject of the tests. The recruiters made sure that the participants had no education in arts, architecture or museum studies. It was decided against testing people over 65 years old, since previous research experiences suggested that such people often have problems with successful eye tracker calibration. It may be due to impaired eyesight, droopy eyelids or finding it difficult to remain relatively still during the test.

At this stage data was collected from 242 people. (It is a sample of a similar or bigger size than in other eye-tracking tests: 20 people [21], 64 people [22], 100 people [23].) 57% of participants were women and 43% were men. All of them lived in the Wrocław metropolitan area. Data collected from twelve people could not be used for various reasons. Seven participants withdrew from the test during its course.

The tests lasted from 10 to 15 min and the participants were rewarded with a 20 PLN voucher. In accordance with the methodology worked out be the author in previous eye-tracking tests [24–26] each image was displayed for 8 s and the participants were divided into groups – during the series of images each group saw only one of the photos in question so that the results would not be influenced by the sequence of presented stimuli or by participants' individual potential in regard to short-term memory [27].

The participants were supposed to focus on a false task – they were to identify whether a given photo was taken in Wrocław or not. They knew nothing about the real aim of the test and how it was meant to be checked. It had been decided that while the participants were being prepared for the test, no one would use the words such as conservation, historical monument, logo, color, marketing, museum, revitalization, adaptation or others that could indicate or subconsciously modify the task they had been given. This way it is possible to say that the perception of the relationship between the logo and the monument was as natural as it was possible under the circumstances and that the cognitive motivation of the participants was highly unified.

Fig. 4. Division into AOIs (Areas of interest) (Marta Rusnak). Markings: yellow – portico; pink – dome and drum, green – walls and windows, orange – logo.

Table 1
Fixations in relation to the entire image and the logo.

No.	Name of AOI →Name of image ↓	Entire image		Logo
1	Without logo	Number of fixations 27.3	Not applicable	
2	White logo	Number of fixations 26.9	Number of fixations	3.4
			People who didn't notice it	1/29 (3.4%)
			Number of revisits	2.2
			Time to first fixation	1.0 s
3	Cream-colored logo	Number of fixations 27.4	Number of fixations	2.3
			People who didn't notice it	2/33 (6.0%)
			Number of revisits	1.9
			Time to first fixation	1.8 s
4	Black logo	Number of fixations 25.6	Number of fixations	1.7
			People who didn't notice it	5/32 (12.5%)
			Number of revisits	1.4
			Time to first fixation	3.3 s
5	Blue logo	Number of fixations 26.4	Number of fixations	3.9
			People who didn't notice it	0
			Number of revisits	2.4
			Time to first fixation	0.6 s
6	Red logo	Number of fixations 29.4	Number of fixations	6.1
			People who didn't notice it	0
			Number of revisits	3.3
			Time to first fixation	0.4 s

Table 2
Average total visit duration - time viewers spent looking at given areas of interest (AOI).

Name of AOI → Name of image ↓	Monument		Portico		Dome and drum	Walls and windows	Logo	Off the monument	Outside the image
	Logo included	Logo not included	Logo included	Logo not included					
	2	3	4	5	6	7	8	9	10
No logo	70.2%	70.0%*	42.1%	41.9%*	19.7%	8.2%	0.2%*	29.8%	5.3%
White logo	75.1%	62.7%	50.2%	37.8%	15.2%	7.7%	12.4%	26.9%	3.9%
Cream-colored logo	71.7%	62.1%	44.1%	34.5%	17.1%	10.5%	9.6%	28.3%	7.5%
Black logo	67.4%	59.6%	36.2%	*28.4%*	**21.3%**	7.9%	7.8%	**32.6%**	**8.2%**
Blue logo	81.8%	65.4%	**59.3%**	**43.0%**	17.8%	6.7%	16.4%	18.2%	3.2%
Red logo	**86.4%**	**66.7%**	55.2%	35.5%	12.9%	**20.3%**	**19.7%**	13.6%	2.6%

Explanation of markings: * the "logo" area of interest had also been designated and included in calculations for the image without the logo, underlined – the lowest value in the given category, **bold type** – the highest value in the given category.

All tested images were divided into AOIs (areas of interest) visible in Fig. 4. The picture was split into four main AOIs recognized as "portico," "dome and drum," "walls and windows," and "off the monument." The "portico" included the subarea named "logo". The sum of areas named "portico," "dome and drum," and "walls and windows" were grouped as "monument". The sky, lawns, pavement and elements of small architecture were all included under the "off the monument" tag. The fixations and saccades of each par-

ticipant were automatically allocated to particular areas of interest. The calculations done by the software gave results presented in Tables 1 and 2.

3.7. Interpretation of eye-tracking data

Due to the nature of this research, not all of participants of eye-tracking study did agree for their data to be shared publicly, so individual supporting data is not available.

3.7.1. Visual aspects of the logo – data relevant to hypotheses 1 and 2

3.7.1.1. Speed of noticing and time spent looking at the logo. A vital visual aspect of information signs is how quickly one can find them. It is reflected in this research by the moment in which the viewers made their first fixation inside the "logo" area of interest. The red symbol was usually noticed as one of the first elements of the image, on average after 0.4 s (Table 1). Fairly good parameters of noticeability also characterized the blue logo (0.6 s) and white logo (noticed on average after 1.0 s).

The data displayed in Table 1 shows that the logos that viewers spent most time looking at were the red one (nearly 20% of time), and the blue one (16.4%), while they spent only 7.8% on average looking at the black logo.

3.7.2. Number of people looking at the logo

The analysis of the fixations related to the information sign itself can tell us how successful the logo is in its primary role. The number of people who overlooked the logo entirely is of particular importance (Table 1). The red and the blue logo were noticed by all viewers these two images were displayed to. The variation that was relatively often missed was the one with the black letter – it was overlooked by 5 people out of 32. The professionals expected the cream-colored logo to be overlooked the most often, while actually only two participants of the test missed it.

3.7.3. Number of revisits

Another important aspect is the number of revisits, which is the number of times their eyes went back to the given logo. The black logo proved to be the least attractive in this respect since more than a half of the participants looked at it just once (an average of 1.4 revisits) and, statistically, the number of their fixations on the logo was less than 2 (Table 1). The cream-colored logo was only slightly better, with the results of 1.9 revisits and 2.3 fixations. The most attractive variation, the red one, was highly dominating since a large part of participants looked at it more than three times.

3.7.4. Visual aspects of the logo – summary

Although not all the expectations of the experts match the results of the eye-tracking tests, it must be observed that the first two hypotheses related to the visual characteristics of the logo were positively verified. The red and the blue logos are visually the most attractive, whereas the cream-colored one and the black one fail as far as their informative function is concerned.

3.7.5. Time spent looking at distinct parts of the image

The first and at the same time the easiest aspect of how the participants comprehended the images is to analyze the average time they spent looking at a particular area of interest (Table 2).

3.7.5.1. Perception of the monument. Time spent looking at the entire monument. The façade of the Four Domes Pavilion that lacked the logo was observed on average for 70.2% of time (Table 2). As far as this image was concerned, the dome and drum AOI was looked at for nearly 20% of time. Once any type of logo was inserted in the image, the time the viewers spent looking at the monument and the information sign was generally lengthened (Table 2, column 2). This did not happen only in the case of the black logo, where the average time the participants spent looking at the monument dropped by almost 5%. The values presented in column 3 show that every logo reduces the time spent on contemplating the architecture of the monument (62.1–66.7%).

3.7.5.2. Time spent looking outside the image. Cognitive interest is probably reflected to the biggest extent by the parameters shown in column 10 of Table 2. The values presented there are related to the length of fixations that fell outside the displayed image, including those outside the screen. Here the sum of fixations ranged from 208 ms (2.6%) for the red logo, to 656 ms (8.2% of time) for the black one. The results shown in the table state quite clearly that the red, blue and white logos contributed the most to the interest the participants paid to the entire image, while the opposite can be said about the cream-colored and the black logo.

3.7.5.3. Total number of fixations. As a result of altering the logo's color, the manner of looking at the monument changed as well. The changes were not limited to the placement of fixations, but also affected their nature. When presented with the image without the logo, the participants made an average of 27.3 fixations (Table 1). This value varied for different logos, achieving the biggest fluctuation for the red and the black logos. The black one reduced the number of eye movements to an average of 25.6 fixations, while the red option increased the viewers' visual activity, resulting in an average of 29.4 fixations.

3.7.5.4. Modified way of looking at the dome. It proves quite intriguing to analyze the sixth column of Table 2, relating to the process of looking at the dome and the drum that supports it. In the reference image that lacked any form of an information sign, statistically the participants spent 19.7% of time looking at this part of the monument. The black logo turned out to be the one contributing the most to proper observation of this architectural element with an increase of 1.6% in comparison to the no-logo variation. While this may be surprising, it seems that the reason behind this rise stems from the fact that when the logo is black, the dome and the drum become the most distinct and vivid part of the displayed composition. What may also come as a surprise is that although the red logo brought about the biggest increase in the time spent on taking in the entire structure, it had very little effect on the attention paid to the dome and its drum. It is also interesting that in this variation the viewers spent more time looking at compositionally less important elements such as the lower parts of the façade on both sides of the portico (the "walls and windows" AOI). It stands in contrast to the tendencies observed in relation to the black logo. It may be assumed that red color is so attractive that it drew people's attention away from the other most significant object of the composition, which is the dome.

What is crucial to both parts of this issue is that 94% of professionals correctly assumed the red color will not benefit the interest in the dome. However, more than 70% of those experts were wrong to expect that it will be the cream-colored logo that will help increase the focus on this part of the monument. Unfortunately, only 30% of professionals rightly assumed that the black logo will support the interest in the dome and the drum to the biggest extent.

3.7.5.5. Perception of the monument – summary. The analysis presented in this part shows that three hypotheses (3, 4, and 5) which were concerned with the relationship between the color of the logo and the perception of the monument, were not confirmed.

4. Results: verification of the research hypotheses

The eye tracking tests did not confirm three out of five research hypotheses established on the basis of the experts' expectations. The two aspects that the professionals managed to make accurate assumptions about, were the ones related to the perception of the logo itself. It means that the experts as a group are aware of the psychological effect different colors have on their viewers. However, both the author and the experts themselves, in the questions related to the best and the worst solution, are of the opinion that the informative function of such a logo is less important than its esthetic relationship with the building it is installed on.

Most professionals proved to lack either the knowledge or the intuition necessary to appropriately assess the influence different colors of the logo will have on the perception of the monument. From the perspective of the effective architectural heritage management, the fact that hypotheses 3, 4, and 5 were not confirmed – which means the experts were unable to predict the actual response of the viewers – suggests that more attention should be paid to learning how such information signs affect the perception of buildings they are placed on.

5. Discussion

The main purpose of this study was not to come up with some sort of a recipe for logo designers, but to test the abilities – or rather the limits – of professionals. It was also meant to show the potential of using eye trackers when consciously adjusting informative signs in historical spaces. The results of the study suggest that guidelines such as the ones mentioned at the beginning, about avoiding bright or too colorful signs in historical context [1], can and should be questioned. Bright symbols, the red and the blue ones, in many respects proved the most desirable. Vivid colors, as the professionals predicted, made the logo itself visually interesting to the public, but – contrary to the expectations of the majority of experts – also successfully encouraged the observers to spend more time looking at the structure the sign was placed on. On the other hand, the toned down options, the cream-colored one and the black one proved boring. One could claim it should be preferable to facilitate spending more time on observing historical monuments since it makes it more probable that people will reflect on the monument and remember it better. This issue requires deeper research, including studies carried out by means of other biometric sensors.

Another feature of the conducted research that demands more discussion is the fact that the study took place in laboratory conditions and not in a real-life situation. Both the participants of the eye-tracking tests and the experts saw the same flat images presented in the same way, on a computer screen. In reality we usually admire architecture "not only using the stereoscopic perception but also from unlimited points of view, which produces entirely new interpretation opportunities, compared to observing them in a photograph or a painting". [28]. Moreover, we may be walking alone or in company, driving, listening to music, talking to a friend etc. Although research based on digitalized stimuli perceived in a soundproof space differ from a free, casual form of coming in contact with a three dimensional space [15], such studies have many advantages – the data gathered is homogeneous, which makes comparative analysis possible. The basis for comparing the results of the eye-tracking test was the fact that only one – and always the same one – aspect of the image was undergoing changes. The use of the same photoshopped images, with the same basic cognitive characteristics made it possible to register responses to variations with different colors and to compare the results of eye-tracking tests with predictions of experts. It could be claimed that it would be better to use an eye tracker in a VR environment. However, one should remember that chosing a specific perspective as well as a specific time to make a recording using a camera or a spherical camera similarly constitutes limiting of reality to a single footage with a single set of unchanging characteristics. The search for a diagnostic tool that would be adequate to a real-life situation of engaging with art is discussed in an interesting way by Kędziora [15]. Nevertheless, the deliberations of this scientist were related to diagnostic research, and not to a comparison of several different variations, which seems to imply a different methodology.

It may not seem very realistic to suggest using eye trackers for systemic and pro-social heritage management, even though the technicalities of conducting eye-tracking tests do not seem very complex. What may be potentially discouraging is small social participation in some countries or the fact that the purchase of the devices and of the professional software is expensive. Moreover, the proper preparation of such an experiment and correct data analysis are time-consuming. It is possible that all these factors along with some debatable aspects of using eye trackers for protection of historical monuments [10] may counterbalance potential benefits.

6. Conclusions

The comparison of experts' predictions with the behavior of lay people shows a significant discrepancy between what education and professional experience suggest and what happens in reality. The difference between the two appears to show that eye-tracking research is not only useful, but even necessary in order to allow experts to understand, interpret and later apply the mechanisms governing the perception of contemporary interventions affecting historical architectural and urban tissue. The presented data may also suggest a need to modify the education received by people dealing with protection of monuments as far as psychology and marketing are concerned.

The tests were concerned with a small-scale intervention – should one decide to make changes on the basis of such research, it would prove both inexpensive and easy. It seems that when it comes to bigger changes that would permanently alter the historical landscape of a place under conservator's care, eye-tracking tests should be even more vital.

Eye-tracking research should be included in the range of diagnostic tools applied when working out both "highly general heritage management plans," as well as more short-term and detailed "action plans" as understood by Fortuna-Marek and Siwek in their 2015 paper "Action Plans as an element of the management system of a world heritage site" [29]. This should apply in particular to UNESCO historical monuments such as the Four Domes Pavilion or the Centennial Hall in Wrocław. This would make it possible to verify the validity of decisions made at the design stage, while conservation decisions are issued, and when previously accepted plans are put into action.

Since "future 'politics of conservation' must also be accepted and supported by society" [30] an eye tracker seems to be a tool that will increase the role of social participation in the process of developing appropriate strategies related to the management of architectural heritage. Our challenge is to confront 'all actors in conservation/preservation with new tasks' [30]. The elementary new task for professionals is now to self-correct themselves and show a greater eagerness to confront their judgment with the way regular people perceive their surroundings.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.culher.2021.02.004.

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